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APPARATUS FOR REDUCING VIBRATION TRANSMISSION IN HAND-HELD TOOL
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- (56) Prior Art Documents  
US 4936394  
US 4385665  
US 4217677
- (57) Claim

1. A hand-held percussive tool incorporating apparatus for reducing vibration transmission from a working tool portion of the tool to the user of the tool, the apparatus comprising first means including a floating, resilient ball arrangement interposed between a handle portion of the tool and the working tool portion and second means for reducing vibration transmission from the working tool portion to a casing of the tool, said second means being located adjacent the working tool portion and between the casing and the working tool portion.

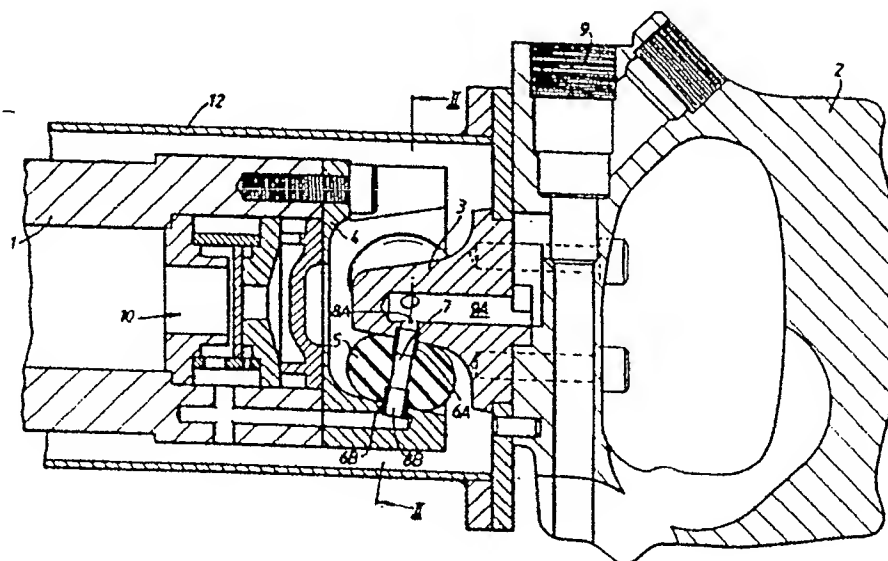


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(54) Title: APPARATUS FOR REDUCING VIBRATION TRANSMISSION IN HAND-HELD TOOL



(57) Abstract

An air-operated percussive tool incorporates apparatus for reducing vibration transmission from a working end portion (1) to a hand grip (2), thereby to reduce vibration transmission to the hand/arm of the user. The apparatus includes a male frustoconical portion (3) whose tip is located facing a female bed (4) with the base of the frustoconical part attached to the handle grip (2) while the bed (4) is attached to the working end portion (1). Three rubber balls (5) are trapped between the portion (3) and bed (4) and the balls (5) are located in their mean positions under compression. Oscillatory movement of the female bed parallel to the longitudinal access of the frustocone causes the balls to roll on the male and female surfaces and effectively provide a rising spring rate or stiffness. Apparatus is also disclosed for reducing vibration transmissions from the working portion to a casing (12) of the tool.

*APPARATUS FOR REDUCING VIBRATION  
TRANSMISSION IN HAND-HELD TOOL*

BACKGROUND OF THE INVENTION

This invention relates generally to an apparatus for reducing vibration  
5 transmission in a hand-held tool and more particularly relates to apparatus for reducing  
vibration transmission from a working portion of a hand-held tool to the user of the  
tool.

Previous attempts to reduce hand/arm vibration in a percussive tool have  
generally centered around either the isolation of the operator's grip by means of sprung  
10 handles or by employing a means of cutting power to the tool as the operator force  
increases.

One limitation of the springs solution is that a damper is required as well as the  
spring in order to obtain the optimum effect. Also, the mass of the sprung handles is  
relatively small compared with the mass of the tool and, since a coil spring usually  
15 functions linearly, high deflections are experienced. As a result, the option to reduce  
the power to help achieve the desired effect has been investigated. Power regulation  
of the tool has obvious disadvantages to efficiency, in that it reduces the blow  
frequency and intensity.

The foregoing illustrates limitations known to exist in percussive tools. Thus, it  
20 is apparent that it would be advantageous to provide an alternative directed to  
overcoming one or more of the limitations set forth above. Accordingly, a suitable  
alternative is provided including features more fully disclosed hereinafter.

SUMMARY OF THE INVENTION

In one aspect of the present invention, there is provided an apparatus for reducing vibration transmission from a working tool portion of a hand-held tool to the user of the tool, the apparatus comprising a floating, resilient ball arrangement  
5 interposed between a handle portion of the tool and the working portion of the tool and second means for reducing vibration transmission from the working tool portion to a casing of the tool, said second means being located adjacent the working tool portion and between the casing and the working tool portion.

The tool may be a percussive tool, such as a chipper, digger, needle gun, scaler,  
10 hammer drill or a demolition tool.

The tool may be air operated. The tool could also be electrically operated.

Preferably, the resilient ball arrangement of the first means comprises balls, preferably three, which can be of rubber, located between a male part on one of the portions and a female part on the other of the portions.

15 The male part can be a substantially frustoconical part joined to the handle portion and the female part can be a female bed joined to the working portion of the tool or vice versa, the bed facing the frustoconical portion with the balls lying compressed on the bed and the external surface of the frustocone.

Oscillatory movement of the female bed parallel to the longitudinal axis of the  
20 frustocone causes the balls to roll on the male and female surfaces.

The balls can be located by pins or the like.

In the case of an air-operated tool, at least one and preferably each ball may be provided with a bore through which air under pressure can be transmitted from the frustoconical portion to the female bed and then to the action of the working part of the tool.

5        According to another aspect of the present invention, there is provided an apparatus for reducing vibration transmission from a working portion of a hand-held tool to a casing of the tool, the apparatus including a floating, resilient ball arrangement interposed between the casing and the working portion of the tool.

10       This resilient ball arrangement of the second means can be in the form of a set of balls in a ring around the internal periphery of the casing and around the outer periphery of part of the working portion of the tool, thereby separating and isolating the two portions.

The set of balls can be linked together.

15       The balls can be located within shells which are curved to urge the balls towards their mean positions.

The foregoing and other aspects will become apparent from the following detailed description of the invention when considered in conjunction with the accompanying drawing figures.

#### BRIEF DESCRIPTION OF THE DRAWING FIGURES

20       Figure 1 is a sectional view of part of a hand-held percussive tool showing apparatus for reducing vibration transmission from a working portion thereof to the user thereof, the tool being illustrated at mid-stroke;

Figure 2 is a sectional view taken on the line II-II in Figure 1;

Figure 3 is an exploded perspective view of part of the apparatus and showing a modification;

Figure 4 is a sectional view of another part of the tool showing apparatus for reducing vibration transmission from the working portion to a casing of the tool, this  
5 view also being illustrated at mid-stroke;

Figure 5 is a section view taken on the line V-V in Figure 4;

Figure 6 is a sectional view to part of Figure 1 and showing a modification of that part; and

Figure 7 is a view similar to part of Figure 4 and showing a modification of  
10 that part.

### DETAILED DESCRIPTION

Referring first to Figures 1 to 3, a D-handled air-operated percussive tool is illustrated which incorporates apparatus for reducing vibration transmission from a working end portion 1 to a hand grip 2, thereby to reduce vibration transmission to the  
15 hand/arm of the user. Such apparatus will be briefly referred to hereafter as the "vibration isolator".

The vibration isolator in the form illustrated comprises a male frustoconical portion 3 whose tip is located facing a female bed 4. The base of the frustoconical part is attached to the handle grip 2, while the bed 4 is attached to the working end  
20 portion 1 of the tool.

Three substantially spherical rubber balls 5 are trapped between the portion 3 and bed 4, which is preferably of scalloped form, the number of scallops corresponding to the number of balls and each scallop serving to receive and locate its ball. The apparatus as depicted in Figure 1 is carrying a mean static load.

The balls are located in their mean positions under compression by means of nylon tubes 6A and 6B located in bores 7 of the balls 5, the tubes having portions protruding from the surfaces of the balls so that these protruding portions are located in corresponding bores 8A and 8B in the portion 3 and bed 4, respectively. The tubes 6A and 6B in each bore 7 are spaced apart to give sufficient clearance for compression and expansion movement of the ball 5 in which the bore is located. The tubes 6A, 6B may be nylon inserts which are glued, bonded or simply press fits.

As illustrated in Figures 1 to 3, the bores can form an integral part of the compressed air supply to the working end portion of the tool from an air supply conduit 9 in the handle grip 2, into a conduit 9A passing down the center of the tapered portion 3 and communicating with the bores 8A, 7, and 8B. The bores 8B lead on to a cycle valve illustrated generally at 10. Experiments have shown that for the operating range of the vibration isolator, the airways through the vibration isolator remain sufficiently consistent to allow the required air flow.

The portion 3 need not be pure frustoconical but can be given a gently curving taper and/or can incorporate an angular change in the direction of taper. The tubes 6A and 6B serve to locate the balls 5 on the taper, especially when the parts 1 and 2 are driven off-center.

In the case where the tool is only electrically-operated, then the tubes 6A, 6B (or pins) simply serve as locating means.

The modification shown in Figure 3 takes the form of three radially-extending wings 11 on the portion 3 which run in slots 12 parallel to the longitudinal axis of the tool. These wings also act as anti-rotation means if the rotational stiffness of the balls is overcome, thereby acting as a travel limiter. Also, they act as a rebound stop or travel limiter in the axial direction.

In use, the percussive tool will oscillate at around  $\pm 0.16$  inches (4mm) at 25 Hz/sec. The acceleration levels experienced with the balls is very high and so the resilient material of the balls must be of a suitable hardness. The apparatus provides a high radial stiffness and a low (soft) axial stiffness with rising rate. In comparison, a normal coil spring would have a constant rate. The balls effectively provide a rising spring rate or stiffness. The rising rate can be varied by varying the degree of slope on the rolling surfaces.

The other end of the tool is diagrammatically illustrated in Figures 4 and 5, where a casing 12 is shown leading up to the handle end of the tool and obviously since the casing 12 is attached to the handle grip 2, it must not be allowed to short out the effect of the vibration isolator. Accordingly, another floating resilient ball arrangement 13 is provided between the working end portion 1 and the casing 12 in the region where the actual tool 14 is located. This effectively forms another vibration isolator but in this case the balls are not provided with locating pins but are linked to the ring of balls and are located in outer and inner shells 15, 16, respectively. The balls may be molded together or may be linked by other means.

In this case, the axial stiffness is intended to be lower, and with a constant rate, but the radial stiffness is intended to be higher than is the case with the vibrator isolator at the hand grip end of the tool. The shells 15 and 16 are curved to urge the bracelet of balls towards their mean positions. The balls are compressed and in this case, they have a shallow curve.

Such a construction at the end of the tool most adjacent the actual tool 14 reduces the required length in that location as compared with prior art bearings and it is resistant to ingress of foreign material. To assist in this, a circular floating seal 17 is provided between the tool 14 and the ball arrangement 13.

Figure 6 shows a possible modification of the construction shown in Figures 1 to 3, in which the air line is not via the balls 5 but via a separate, flexible hose is connected between the hand grip 2 and the reciprocating portion 1. There are still three balls 5, each located in its own scalloped portion on the bed 4.

- 5        As with the embodiment shown in Figure 1, the male portion 3 can be provided with planar or substantially planar faces.

- 10       The reciprocating portion 1 is guided by three toughened pins 19 extending from the hand grip 2 parallel to the axis of the tool, each pin running as a loose fit in its own hardened bush 20. This construction provides guiding and anti-rotation means for the portion 1.

- 15       Figure 7 shows a possible modification of the construction shown in Figures 4 and 5, in which the bracelet of balls at the actual tool 14 end is replaced by a plain sliding bearing. This comprises a bed of 21 of polymer fitted around the portion 1 and a part-spherical, radiussed bearing tip 22 which can be hardened steel flash chromium plated. A slight clearance is provided to allow for "blow past", which provides self-cleaning and allows for expansion.

Another possibility, not illustrated, would be to provide a roller bearing running on flats on the portion 1 and provided with end stops. Yet another possibility would be to provide an air bearing.

What is claimed is:

1. A hand-held percussive tool incorporating apparatus for reducing vibration transmission from a working tool portion of the tool to the user of the tool, the apparatus comprising first means including a floating, resilient ball arrangement  
5 interposed between a handle portion of the tool and the working tool portion and second means for reducing vibration transmission from the working tool portion to a casing of the tool, said second means being located adjacent the working tool portion and between the casing and the working tool portion.
2. A tool according to claim 1, wherein said resilient ball arrangement  
10 comprises three balls located between a male part on one of the portions and a female part on the other of the portions.
3. A tool according to claim 2, wherein the balls are of rubber.
4. A tool according to claim 2 or 3, wherein said male part is a substantially frustoconical part joined to said handle portion and the female part is a  
15 female bed joined to a working part coupled to the working tool.
5. A tool according to claims 2, 3 or 4, wherein the balls are located by pins or the like.
6. A tool according to claim 4 or claims 4 and 5, wherein at least one of the said balls is provided with a bore through which air under pressure can be  
20 transmitted from the frustoconical portions to the female bed and thence to said working part.

SUBSTITUTE SHEET

7. A tool according to claim 4 or 5, wherein a flexible hose is provided through which air under pressure can be transmitted from the handle portion to said working part.

8. A tool according to any one of the preceding claims, wherein said  
5 second means includes a second, resilient ball arrangement.

9. A tool according to claim 8, wherein said second resilient ball arrangement is in the form of a set of balls in a ring around the internal periphery of the casing and around the outer periphery of part of the working tool.

10. A tool according to claim 9, wherein the balls in said set of balls are  
10 linked together.

11. A tool according to claim 9 or 10, wherein the balls of the set of balls are located within shells which are curved to urge those balls towards their mean positions.

12. A tool according to any one of the claims 1 to 7, wherein second means  
15 comprises a sliding bearing.

13. A tool according to claim 12, wherein said sliding bearing comprises a radiussed bearing tip running on a bearing bed.

14. A tool according to claim 13, wherein said bearing tip is of hardened steel and said bearing bed is of a polymer.

20 15. A tool according to any one of claims 2 to 14 and further comprising means to limit relative rotation between said male and female parts.

16. A tool according to claim 15, wherein said means to limit relative rotation comprises pins extending parallel to the axis of the tool.

17. A tool according to any one of claims 2 to 16, and further comprising means for acting as a rebound stop or travel limiter in an axial direction of relative  
5 movement of the male and female parts.

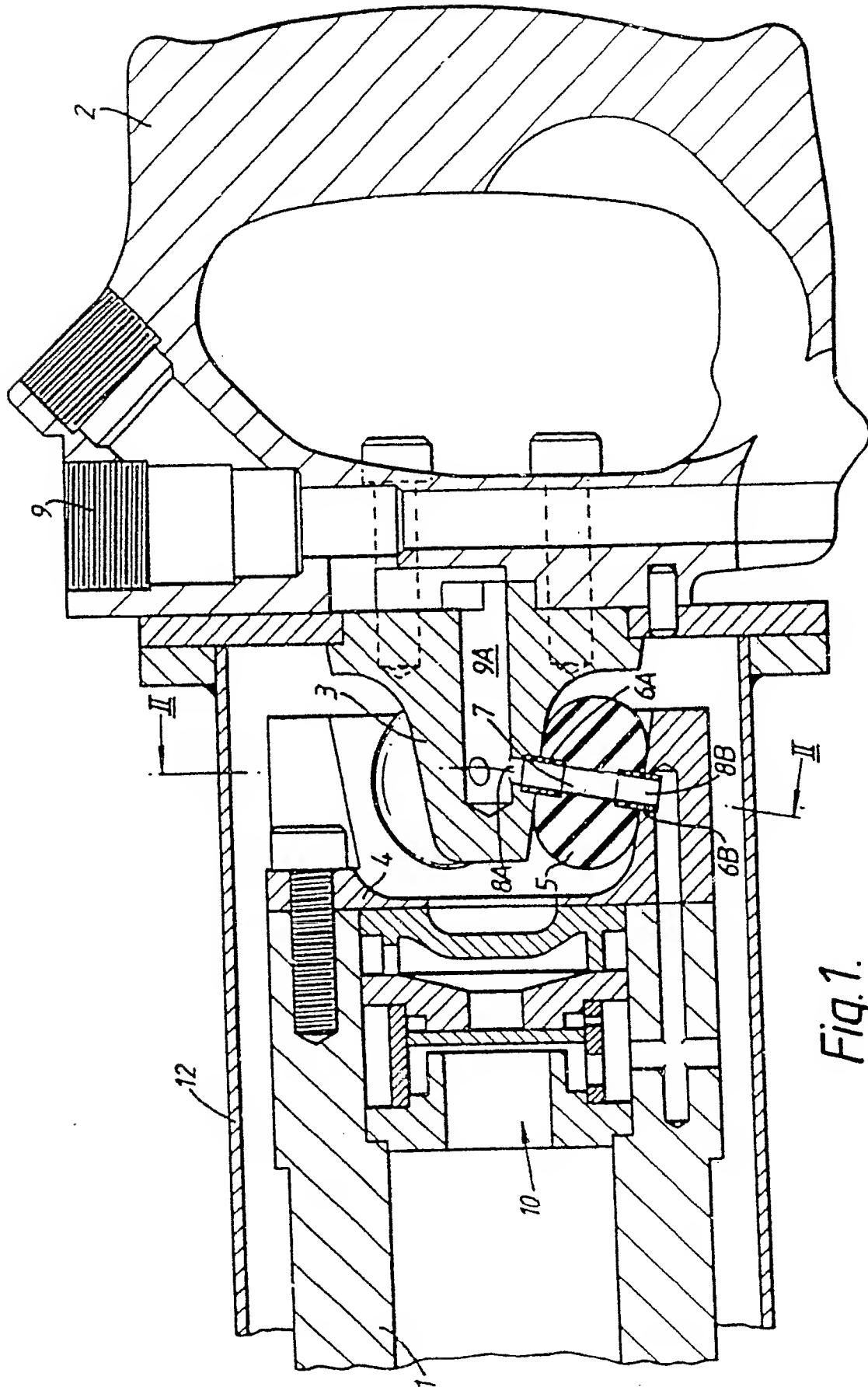
18. A tool according to any one of the preceding claims and being air operated.

19. A tool according to any one of claims 1 to 17 and being electrically operated.

10 20. A tool according to any one of the preceding claims and being in the form of a chipper, digger, needle gun, scaler, hammer drill or a demolition tool.

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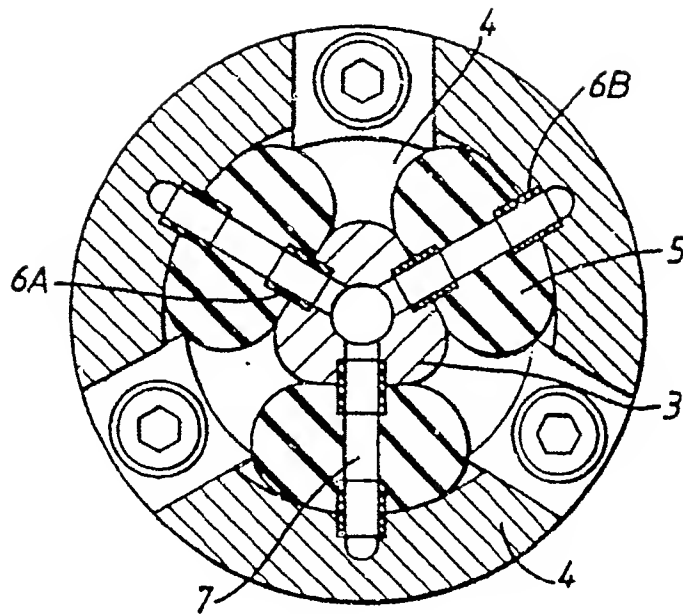


Fig. 2.

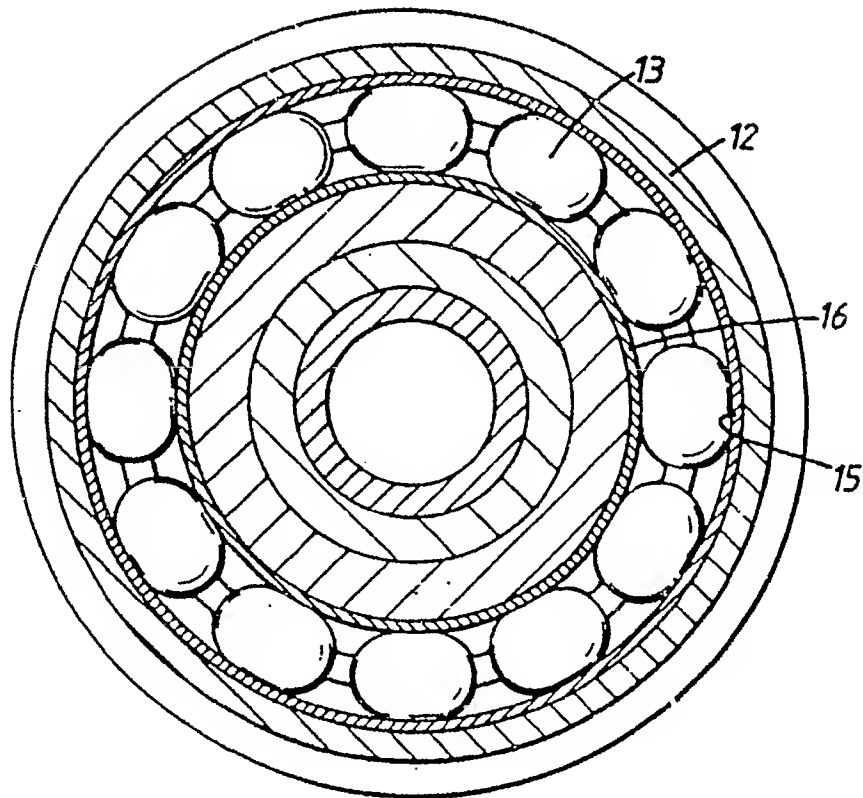
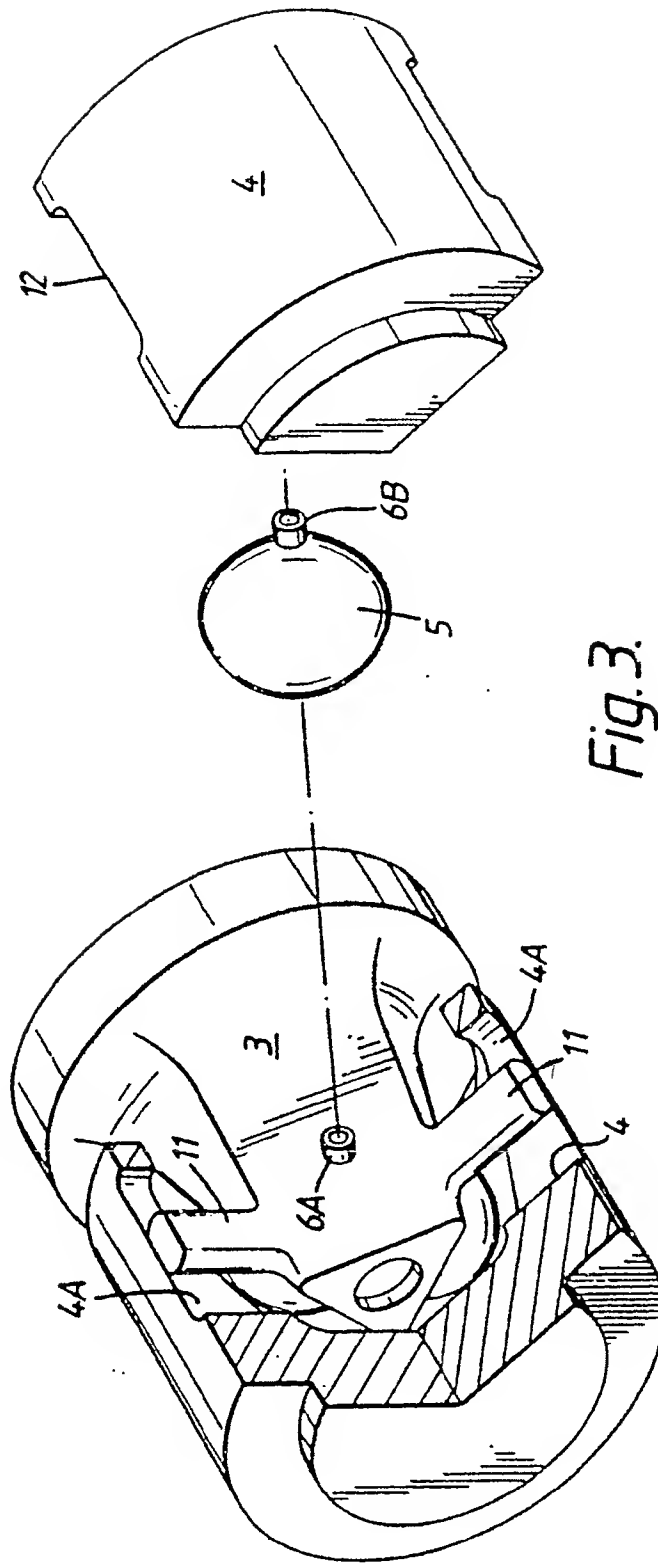


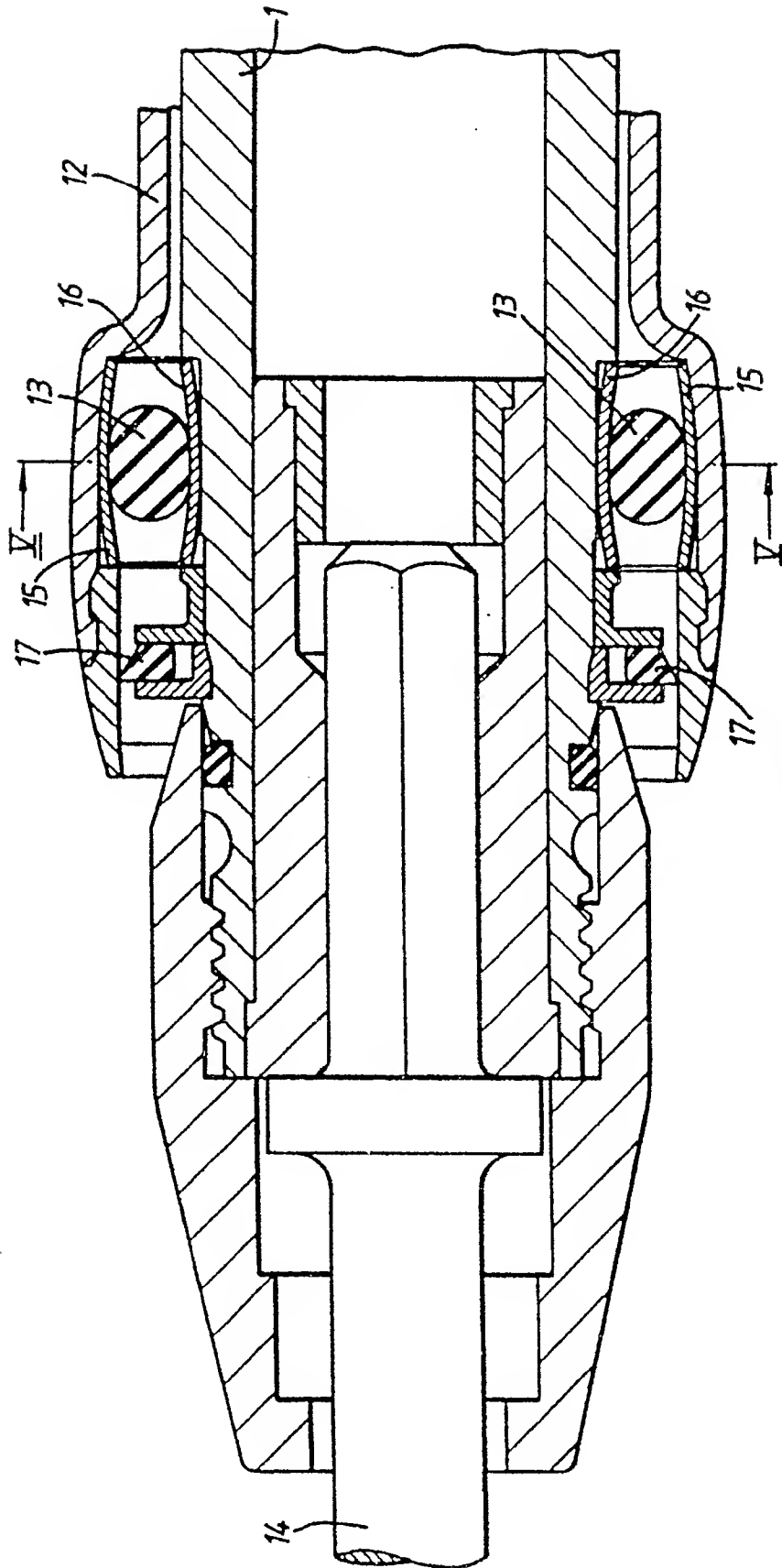
Fig. 5.

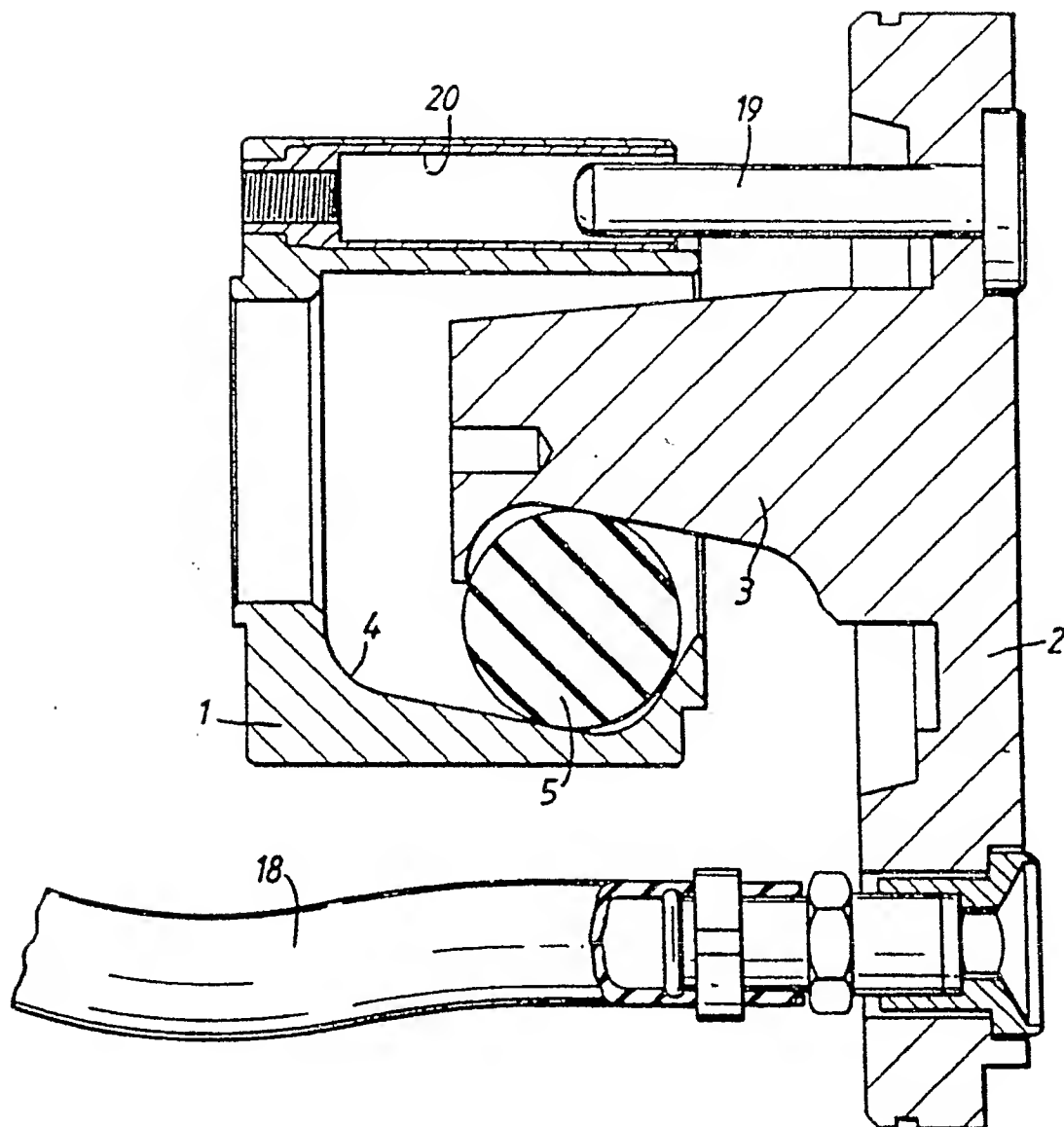
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*Fig.6.*

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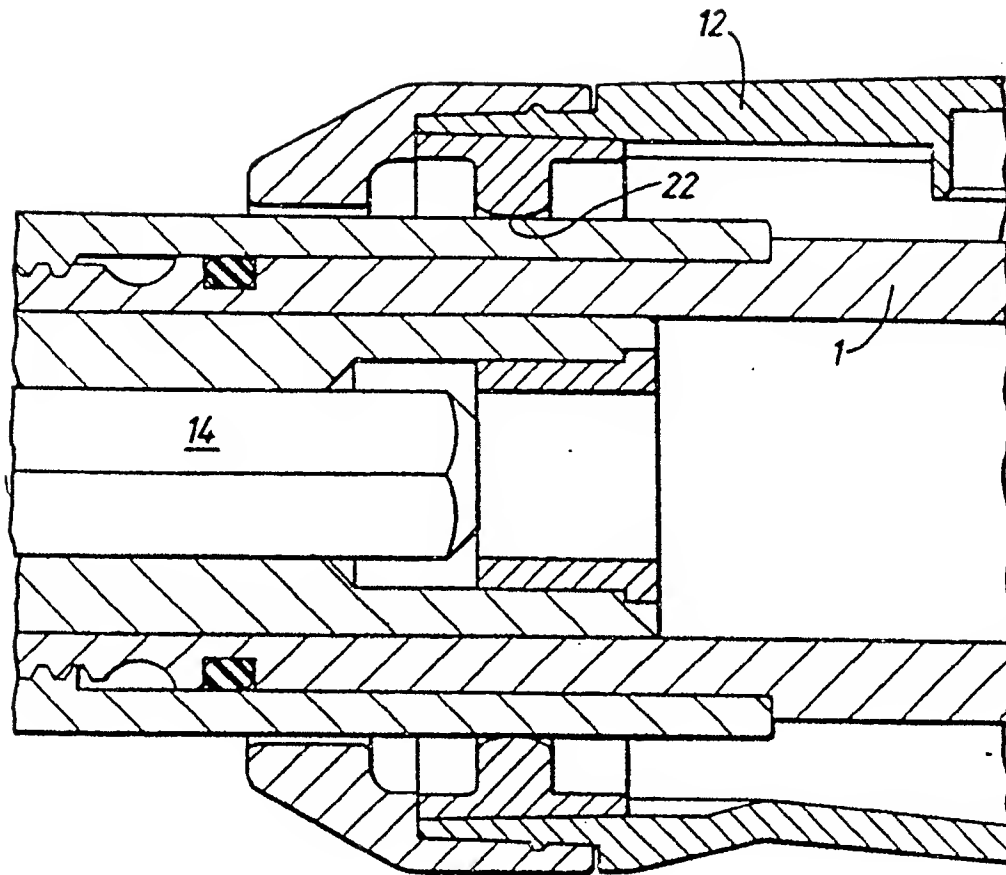


Fig.7.

**A. CLASSIFICATION OF SUBJECT MATTER**

IPC(5) :B25D 17/00

US CL :173/162.1,162.2,211; 30/381

According to International Patent Classification (IPC) or to both national classification and IPC

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

U.S. : 173/162.1,162.2,211; 30/381

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US,A, 4,936,394 (Ohtsu) 26 June 1990 See the entire document.	1-4
A	US,A, 3,525,373 (Kobayashi) 25 August 1970 See the entire document.	1-4
A	US,A, 4,074,777 (Andersson et al.) 21 February 1978 See the entire document.	1-4
A	US,A, 4,217,677 (Sumikawa) 19 August 1980 See the entire document.	1-4
A	US,A, 4,385,665 (Knoll) 31 May 1983 See the entire document.	1-4

☒ Further documents are listed in the continuation of Box C.
 ☐ See patent family annex.

* Special categories of cited documents:	* T	later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
* A		document defining the general state of the art which is not considered to be part of particular relevance
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	* Z	document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
10 FEBRUARY 1993	12 MAR 1993
Name and mailing address of the ISA/US Commissioner of Patents and Trademarks Box PCT Washington, D.C. 20231	Authorized officer <i>Andie Robinson</i> SCOTT SMITH
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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/US92/10871

## C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US,A, 4,401,167 (Sekizawa et al.) 30 August 1983 See the entire document.	1-4
A	US,A, 5,054,562 (Honsa et al.) 08 October 1991 See the entire document.	1-4